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tween the cakes. To-day (Aug. 22) I was called to look at some of the results, and I send you a rough drawing of one of the germinated rye seeds. You will notice that the roots pushed out laterally between two blocks of ice; the shoot, or stem, did the same for half an inch, but then turned upwards at a right-angle and penetrated the solid ice vertically for a distance of two inches.

"No matter how the seed lay, whether with its germinating point up, down or sideways, the growth was always in the true vertical through the solid ice.

"I have seen, in 1882 and 1883, at least fifty similar cases occurring in this ice-house."

Pending nominations, Nos. 985 to 1004, and new nominations, Nos. 1005, 1006, were read.

The President reported that he had received, and paid over to the Treasurer, \$132.75, being the interest on the Michaux rentes, last due.

And the meeting was adjourned.

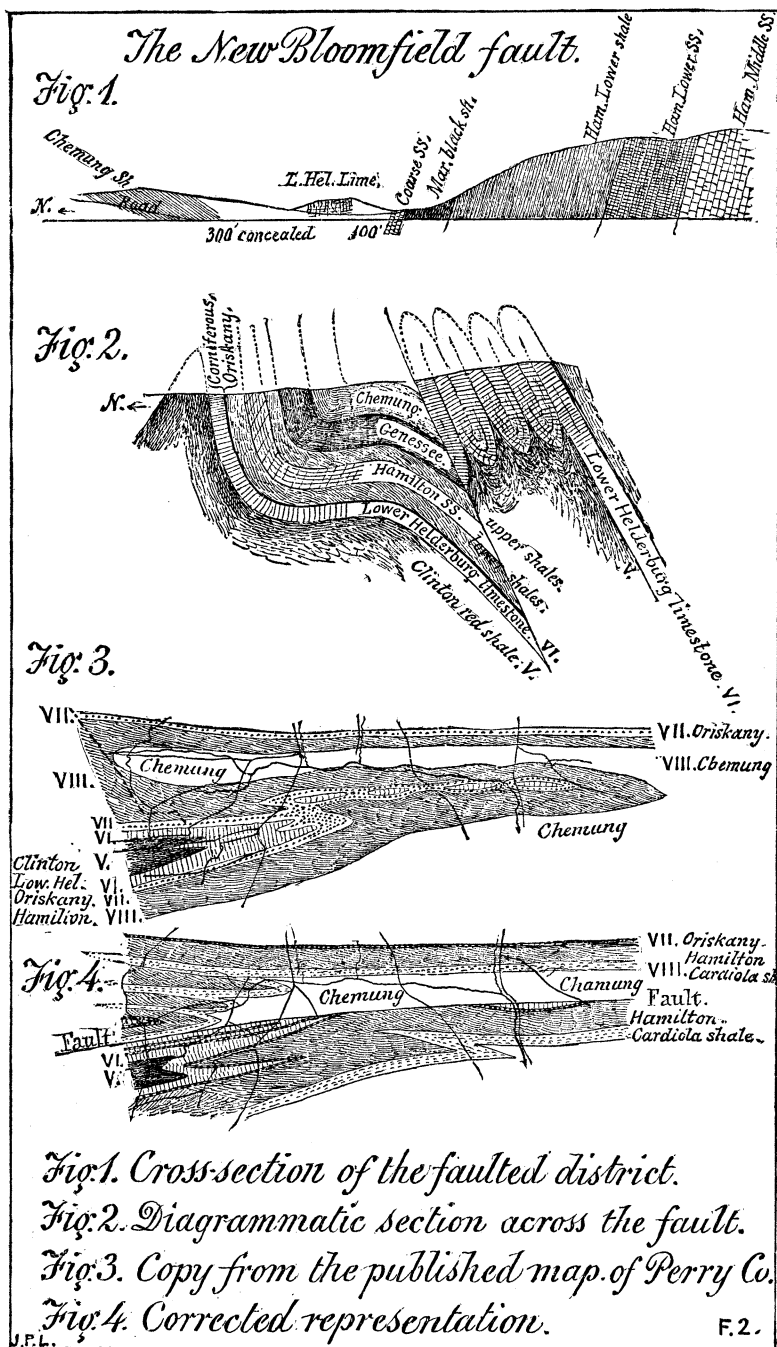
The Perry County Fault. Note on an important Correction in the Geological Map of Pennsylvania. By E. W. Claypole.

(Read before the American Philosophical Society, April 20, 1883.)

THE DISTRICT IMMEDIATELY SOUTH OF NEW BLOOMFIELD.

The country lying immediately south of Mahanoy ridge, is one of the best collecting grounds that I have found in the county for the fossils of the Hamilton and Chemung groups. The Upper Hamilton shales are there exposed better than I have found them elsewhere, and the Chemung, especially the lower part of the group, may also be examined in many small wayside cuts and field-exposures.

But very soon after beginning to work this field I became aware that some difficulty hitherto unrecognized stood in the way of deciding the horizon from which the fossils came. It was impossible to recognize the different rocks according to the views expressed in the preliminary map of Perry county. References to this geological map of the county will show that the ground between Mahanoy ridge and Dick's hill is there represented as a close syncline bounded by outcropping edges of Hamilton sandstone, the middle of which is occupied by a sheet of Chemung rocks. But a very short examination sufficed to show that the Hamilton Upper shales extended much farther out into the valley from Mahanoy ridge



than the bounding line drawn on the map. Hamilton fossils were found farther and farther out from the ridge in the grounds represented as Chemung on the map, until it become evident that in the western part of the basin or trough the Hamilton Upper shales were repeated by the extension to the eastward of one of the anticlines represented at the end of the trough. Crawley hill is a mass of Hamilton sandstone rising immediately to the south of the township road running to Little Germany at a point not more than three miles from Bloomfield. The influence of this anticline is to bring up the Hamilton Upper shales again to the surface so that the lower beds crop out at or near the school-house on the branch road to the south. Continuing along the branch road these Hamilton shales still occupy an immense space, far more than their thickness, and yet they dip very steeply. Another anticline, running up from the south-west, produces another repetition. The crest of the Hamilton Sandstone ridge which encloses on the east the Perry Furnace valley throws up the upper shales again, so that in passing south, about half a mile from the New Bloomfield and Little Germany road, one passes over two anticlines rising first to the top layer of the Upper Hamilton shales or perhaps even into the Genesee, then descending to the edge of the Hamilton sandstone, again rising over the syncline and again descending on the second anticline. Nor is it until both the ridges have been passed over that one finds the strata regularly dipping outwards at an angle of almost 90° from the last anticlinal axis.

The consequence is that the Chemung rocks do not occur, as represented upon the map, along the middle of the eastern part of the valley. The whole of this area is occupied by Hamilton shales. The area, colored to represent Hamilton rocks on the map, between the roads leading to Perry Furnace and to Gibson's rock is occupied by rocks of later date. Most of them are the equivalents of the Portage-Chemung, very similar in appearance.

In fact, among the slight though rather numerous exposures of shale occurring in this valley, it would be almost impossible without the assistance of palæontology to determine their different horizons. Even with this aid, the difficulty, although diminished, is not removed. Many of the beds are totally barren; but, by the study of the fossils yielded by others the folds and varying angles of dip were followed out and Chemung fossils and rocks were found to occupy the whole southern side of the Middle basin, close up to the foot of its bounding range, Dick's hill and Iron ridge. Inasmuch as the base of these hills is in many places occupied by limestone, it is evident that two so distant horizons can only be brought into contact by a fault.

Following the various roads out of New Bloomfield it is not difficult to trace this fault through the county.

No. 1. The Ridge road to Carlisle. On this line the successive formations occur in regular sequence from New Bloomfield for about two and one-half miles, when the ground suddenly changes from Chemung shale to Lower Helderberg limestone.

No. 2. Old road to Carlisle. The same result is obtained along this line. At about two miles from New Bloomfield is a small roadside cutting showing Chemung shale and at about one hundred yards further on is an indistinct but manifest Oriskany ridge. Between the two is a narrow strip of Lower Helderberg limestone.

No. 3. West road to Gibson's rock. At about two miles and a half from New Bloomfield, the lower Portage bed (*Cardiola* shale) dipping at nearly 90° crops out on the roadside, and within one hundred yards the road passes over the Oriskany sandstone (near Mr. S. Brown's).

No. 4. Road to Montebello narrows. This road, running almost due east, passes over a great distance of Chemung shales rising to a higher horizon than along either of the roads already mentioned. But on turning to the south at the entrance to the narrows two cuttings, only one hundred and fifty yards apart, show the Chemung shales and the lower Helderberg limestone.

No. 5. Road from Perry Furnace to Gibson's rock. The old Perry Furnace lies upon the lower Helderberg limestone. The Oriskany sandstone does not make any conspicuous ridge along this road. But at a few hundred feet south of the Furnace the base of the Hamilton sandstone is seen and passing through the narrows its upper limit may be easily detected. Following this at a distance of about four hundred feet comes in the Oriskany sandstone, forming a distinct ridge of rocks. The fault therefore comes through in this interval, bringing the Lower Helderberg limestone in contact with the Hamilton Upper shale. The throw here is less than farther east, not exceeding 1650 feet measured at right angles to the beds, or 2300 feet if measured vertically.

No. 6. Road to Losh's run (Polecat road and Ohio Wharf road). This road strikes the line of fault about six miles east from New Bloomfield. The exposures are not quite so striking as in the places already mentioned, but the fault is equally conspicuous. Chemung shales occupy the ground south from Mahanoy ridge to Dick's hill with, so far as can be determined, a tolerably uniform dip of about 40°. Immediately at the northern foot of Dick's hill the lower Helderberg limestone is quarried. Though no cutting showing the shales can be seen close to the quarry, yet the surface of the fields shows the presence of the Chemung sandstone, and, from the color, it is apparently nearer the top than the bottom of the group. Some indications also are present, which seem to show that the yellow shales and brown sandstones of the beds underlying the limestone, are brought up into contact with the Chemung. The throw of the fault here is consequently greater than at any one of its western exposures, amounting, if measured square across the beds, to about 4650 feet, or vertically 6510 feet.

Westward of the lines hitherto followed the fault may be traced. It cuts off the Hamilton sandstone of South Furnace ridge, which declines in consequence to the general level of the country. This extinction of the Hamilton Sandstone ridge takes place about two miles south-west of the

Perry Furnace. It cuts through the Oriskany ridge, almost at the point where the two outcrops are about to meet, and passing out of the Oriskany near the high point behind Adam's Glen school-house, near Landisburgh, cannot be followed through the monotonous red shale, of which the valley consists. There is, however, no ground for supposing that it continues into the Blue mountains, no traces of displacement being visible in Kennedy's valley or on Pilot Knob.

Eastward beyond the display near Montebello narrows, described above, the fault continues, and its investigation becomes difficult. After leaving the exposure at No. 6, which is about a mile east of the narrows, and where the throw is greatest, it suddenly diminishes. The Hamilton sandstone which has been faulted up and has formed the monoclinical ridge of Dick's hill, suddenly sinks and vanishes underground. The land being low it is not easy to find evidence of its presence, but sections along the river and in Watts township show that it continues to Half Falls mountain.

From the facts that have been collected the only possible conclusion is that the fault here doubles itself and rapidly diminishes. The line already traced continues nearly along the course of Losh's run and forms the most southern of the four separate ranges of Hamilton sandstone, which together form Half Falls mountain. About the meridian line on which the sudden descent of the Hamilton sandstone takes place and Dick's hill disappears, a subsidiary fault develops itself about half a mile northward, near the end of Mahanoy ridge and continues to and across the river where it throws up a third ridge of Hamilton sandstone immediately south of the second and nearly equaling it in height.

These two minor faults—extensions of the Perry County fault—run westward along the range of Half Falls mountain to a distance which it is not possible to determine without a greater expenditure of time than the other work on the county would justify. The southern fault probably has but a short range, but the northern not improbably runs for two or three miles.

The fault here described is thus shown to be one of no trifling extent, having been traced in the above notes about eighteen miles along its outcrop from E. N. E. to W. S. W. The changes which it renders necessary on the map are considerable. The whole outcrop of the Hamilton rocks ranging along the north side of Dick's hill must be canceled and its place occupied by Chemung shales. The great patch of Chemung shales in the western end of the valley must be replaced by Hamilton and the Hamilton by Chemung. These changes may be seen in a moment by comparing two sketch maps accompanying this paper with one another. The narrow middle valley of Perry county is not a syncline but a monocline. Half of it has been removed and elevated above the level of the rest, from which height it has been washed by atmospheric action and swept into the Atlantic.

The mass of material thus removed will be evident when the diagram shown below is compared with the maps and with the figures showing the amount of "throw" of the fault. This section, though not

drawn minutely to scale is yet sufficiently accurate for our present purpose. It occurs at Montebello narrows about four miles from New Bloomfield and shows what would be seen, if the exposure of the rocks permitted, along the whole course of the fault. The details, such as the amount of throw and the horizons brought into juxtaposition, would vary to some extent, but these variations do not in any way affect the principle.

The fault is indicated on the surface only by a slight and interrupted depression, not in any way noticeable; but along at least a part of its course it is marked by a line of strong springs. So evident is its course, when the structure of the county is understood, that a man can stand with one foot on the Chemung shales and the other on the Lower Helderberg limestone.

Throw.—In estimating the throw of this fault it must be remembered that it is not everywhere of the same extent. At its greatest the olive shales of No. 8, the Chemung, are brought into contact with the limestone of No. 6, the Lower Helderberg. If we then calculate the throw where it is greatest we shall get the following results. The part of the Chemung appearing at the surface at the fault is as near as I can determine about 2000 feet above the base of that group, including the Portage:

			Feet.
Partial thickness of Portage-Chemung (lower portion) .			2000
Total	"	" Genesee shale.....	200
"	"	" Hamilton Upper shale.....	300
"	"	" Hamilton sandstone.....	600
"	"	" Lower Hamilton shale.....	500
"	"	" Marcellus Black shale.....	100
"	"	" Marcellus limestone and shale.....	50
"	"	" Oriskany sandstone and shale.....	100
Partial	"	" Lower Helderberg limestone.....	200
Total	"	" rocks thrown by the fault	4050

This, within certain small limits of error, is the amount of throw calculated at right angles to the bedding. The total dislocation is, however, much greater. The tangential or horizontal thrust, to which is due the folding of the Appalachian strata and their accompanying or subsequent fracture, forced the the rocks on the S. E. side of the fault over those on the N. W. side, along a slope whose angle cannot be determined. It has been represented in the section at 45° , but was probably less. If the amount above given be now increased in the proportion of the sine of this angle to the radius, or multiplied by about 1.4, we shall obtain as the actual displacement of the strata along the line of the fault about 5600 feet.

THE LITTLE GERMANY FAULT.

Further investigation has developed another fault parallel to the first and at the distance of about a mile to the northward.

It develops itself near the hamlet of Little Germany, in Spring township, and runs east-north-east into Centre for nearly five miles. Though

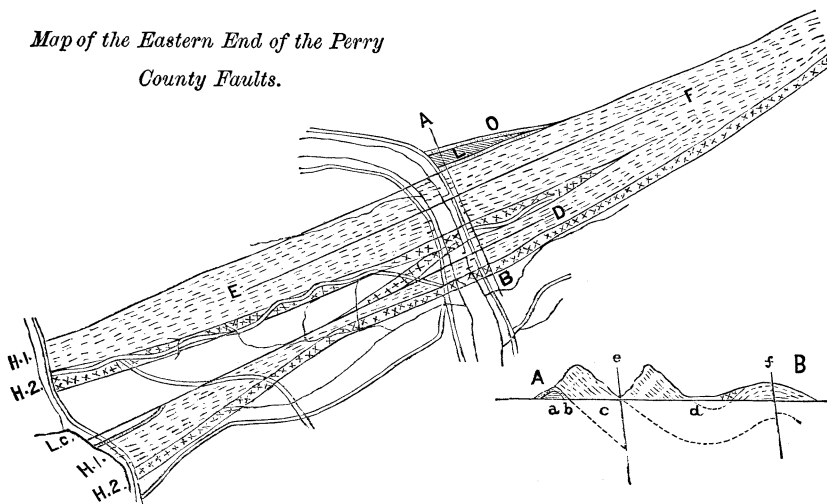
far inferior in length and throw to the Perry County fault it yet produces much complication and several noteworthy changes in the topography and landscape.

The most westerly point at which I have been able to detect the fault is on the hill west of Little Germany, where it produces a fork in the Oriskany sandstone, one ridge continuing on its previous course, while the other diverges slightly to the southward. The latter thrown up by the fault is cut off at a short distance, the ridge terminating in a field.

In thus bringing up the Oriskany to the surface, the dislocation has also brought up the Lower Helderberg limestone adjoining it, and the result is that limestone has been quarried and burnt at one place, while at the distance of about 100 feet northward, or geologically speaking *below* it, lies

FIG. 5.

*Map of the Eastern End of the Perry
County Faults.*



H. 1. Hamilton sandstone and Lower shale.

H. 2. Hamilton Upper Shale.

O. Oriskany, &c.

L. Limestone.

E. F. Fault.

C. D. Fault.

the Marcellus Black shale with no intervening Sandstone ridge. The Marcellus thus occurs on *both* sides of the narrow belt of limestone. Following the line of fault a little farther to the east, we find the Lower Hamilton shale brought up on the south side against the Marcellus on the north, and farther yet the lower shale, about 500 feet thick, occupies both sides of the fault. As we approach the township line, which lies on the watershed parting the south fork of Montour run from the tributary of the Little Juniata, a high connecting ridge of Lower Hamilton shales rises on the south side of the fault, exposing the Marcellus at its base, into which a tunnel six feet square in section has been driven in search of coal.

The north side is occupied by the Hamilton sandstone, through which the fault here cuts obliquely and the throw having increased it causes a lateral displacement of nearly a mile, through which the road passes from the Lower to the Upper shale without crossing any Sandstone ridge.

Entering Centre township, the fault passes along the strata as they rise to the Crawley arch, leaving the synclinal west end of Mahanoy ridge separated from the anticlinal east end of Crawley hill. The latter is so far eroded as to expose the Hamilton Lower shale for more than two miles from Little Germany.

The throw is greatest near the watershed on the township line, where the lower part of the Lower Hamilton shale is brought up against the Upper Hamilton shale and may be estimated thus :

Upper Hamilton shale (part).....	150 feet.
Hamilton sandstone.....	600 “
Lower Hamilton shale (part).....	400 “
	<hr/>
	1150

But as the beds dip at about 45° , the actual vertical displacement is more, being in proportion to the sine of the angle of dip. This will give 1600 feet. The Little Germany fault extends into Centre township almost to Bloomfield, gradually dying out. But it may be traced by a slight valley, and by the increased thickness of the Hamilton Upper shale, as far at least as the residence of Mr. William Brunner. Its total length is about four and a half miles.

INTERMEDIATE FAULT.

Yet further in this connection, a third fault of small dimensions passes between the two above described. Manifesting itself near the house of Mr. George Meck, it causes a repetition of the Hamilton sandstone, bringing the middle and upper beds to the surface after they have dipped south from the Crawley anticline.

This fault is of no great extent, apparently disappearing in a mile and a half. Nor is its throw more than about 200 or 300 feet. But it makes a distinct short ridge of Hamilton sandstone, and a deep intervening valley between it and Crawley hill.

N. B.—In consequence of the discovery of this third dislocation, a slight correction is rendered necessary on the map representing the eastern end of the Perry County fault. The middle one of the three short anticlines there represented, is the small ridge thrown up by the third fault, and is therefore monoclinal, with south-east dip, and not anticlinal in structure.